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Department of Economic Studies, University of Dundee, Dundee. DD1 4HN

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The demand for intensity versus frequency of alcohol consumption: Evidence from rural Australia

Dennis Petrie[a,b,#], Christopher Doran[c], Anthony Shakeshaft[c], Rob Sanson-Fisher[d]

[a]University of Dundee, Economic Studies
[b]University of Queensland, School of Population Health QLD 4072
[c]University of New South Wales, National Drug and Alcohol Research Centre NSW
[d]University of Newcastle, Faculty of Medicine and Health Science NSW

Abstract

This paper develops a theoretical model for the demand of alcohol where intensity and frequency of consumption are separate choices made by individuals in order to maximize their utility. While distinguishing between intensity and frequency of consumption may be unimportant for many goods, this is clearly not the case with alcohol where the likelihood of harm depends not only on the total consumed but also on the pattern of use. The results from the theoretical model are applied to data from rural Australia in order to investigate the factors that affect the patterns of alcohol use for this population group. This research can play an important role in informing policies by identifying those factors which influence preferences for patterns of risky alcohol use and those groups and communities who are most at risk of harm.

Keywords: alcohol, demand model, patterns of consumption

JEL Classification: I10, D11, D12.

[#] Corresponding author, Economic Studies, University of Dundee, 3 Perth Road, Dundee, UK, DD1 4HN. Email: d.j.petrie@dundee.ac.uk. Tel: +44 1382386164. Fax: +44 01382 384691.

Introduction

In Australia in 2004, 58% of males and 41% of females (over 14 years old) consumed alcohol at least once a week (Australian Institute of Health and Welfare, 2008), while in the United Kingdom (UK) in 2006, 71% of males and 54% of females had an alcoholic drink in the week prior to interview (Goddard, 2008). Alcohol can, however, cause a significant amount of harm, not only to the individual but also to the family and community to which they belong. For example, in Australia, the total social cost of alcohol in 2004/2005 was estimated at $15,318 million (Collins and Lapsley, 2008).

Epidemiological and social studies have increasingly pointed to the importance of drinking patterns in explaining consequences of alcohol consumption (McElduff and Dobson, 1997; Mukamal et al., 2003; Rehm et al., 1996; Rehm and Gmel, 1999). A relatively low frequency of drinking together with the consumption of a high number of drinks per occasion (high intensity) can lead, through the mechanism of acute intoxication, to a variety of medical and social problems, such as accidents, injuries, interpersonal violence, and certain types of acute tissue damage (Babor et al., 2003). In policy terms, therefore, there exists a clear rationale for understanding the factors that affect an individuals' choice of how much (intensity) and how often (frequency) to consume for certain goods like alcohol (Berggren and Sutton, 1999).

Economic studies that examine determinates of alcohol consumption generally model those factors which affect the total quantity consumed or total expenditure on alcohol of an individual/household (Clements and Johnson, 1983; Clements and Selvanathan, 1991; Gius, 2005; Johnson and Oksanen, 1974). A limited number of economic studies have also examined determinates of the frequency of binge drinking (Chaloupka and Wechsler, 1996; Manning et al., 1995; Moore and Cook, 1995). However, there is a paucity of research that

explicitly uses a theoretical model which attempts to explain why, and how, individuals choose both the intensity (number of drinks consumed on each occasion) and frequency at which they consume. Berggren and Sutton (1999) using a traditional demand model, which splits intensity and frequency in terms of their effect on the budget constraint, reject the 'quantity hypothesis' and conclude that consumers are not indifferent to the intensity and frequency of alcohol consumption.

This paper explores a theoretical model where an individual maximises his/her utility, subject to diminishing marginal utility, with reference to both the intensity and frequency at which alcohol is consumed. An empirical example is then considered in order to analyse the determinants of alcohol consumption patterns for individuals in rural NSW.

Theoretical Model

In the following analysis, it is considered that individuals receive differing amounts of utility depending on their intensity and frequency of alcohol consumption. Assume an individual is faced with two consumption goods (x and y), where the total utility (U) for the period depends upon both the intensity (average quantity of good x consumed on each occasion (q_x)), the frequency at which good x is consumed (f_x), and the total quantity of good y consumed (Q_y) as shown in Equation(1).

$$(1) U = h(q_x, f_x, Q_y)$$

The individual is also faced with the budget constraint $M \geq p_x q_x f_x + p_y Q_y$ where M is the total available income for the period and (p_x and p_y) are the price of goods x and y respectively.

It is assumed that individuals receive diminishing marginal utility with respect to both intensity and frequency of consumption in the period. This assumption will ensure that diminishing marginal utility also holds with respect to the total quantity of good *x* consumed. For simplicity, it is assumed that both the intensity and frequency of consumption are continuous variables.

Solving the Lagrangian (Appendix A), by maximising utility subject to the budget constraint finds that:

$$(2)\ \frac{\partial U}{\partial q_x} \Big/ f_x = \frac{\partial U}{\partial f_x} \Big/ q_x$$

This implies that the marginal benefit of a unit increase in average quantity of good *x* per consumption occasion is equal to the marginal benefit of a unit increase in the frequency at which good *x* is consumed. If the marginal benefit of a unit increase in an average quantity of good *x* per consumption occasion was greater than the marginal benefit of a unit increase in frequency, then the individual could increase his/her total utility while keeping the total amount spent on good *x* the same by increasing the intensity of consumption and decreasing frequency of consumption.

Functional Form

It is assumed that intensity and frequency enter the utility function in a multiplicative form. This is convenient because it rules out the possibility of having one non-zero and one zero solution for intensity and frequency of consumption. It is assumed that total utility is the sum of function *h* which depends only on q_x and f_x and another function *g* which depends on the quantity consumed of other goods (Q_y) as shown in Equation(3).

$$(3)\ U = h(q_x, f_x) + g(Q_y)$$

Cobb-Douglas Utility Function

If both intensity and frequency enter into the utility function in a simple multiplicative form such as the Cobb-Douglas functional form in Equation(4) where $\phi \neq \gamma$, then the optimal choice is a corner solution, such that either frequency approaches zero (or the lowest frequency unit possible) and intensity approaches infinity, or frequency approaches infinity (or highest frequency possible) and intensity approaches zero. Obviously these are unrealistic outcomes because people consume at intensities and frequencies between these ranges. Alternatively, if $\phi = \gamma$ then the intensity and frequency of consumption are perfectly substitutable and, thus, total utility would be the same regardless of the choice of frequency and quantity for a given total quantity. If this was the case, then the ratio of frequency to quantity consumed on each occasion is likely to be a randomly distributed variable.

$$(4) U = q_x^{\phi} f_x^{\gamma} + g(Q_y)$$

Multiplicative Quadratic Utility Function

A more complicated model which allows for greater flexibility is where the utility function takes the form of a multiplicative quadratic model in both the quantity consumed on each occasion and the frequency at which it is consumed: Equation(5). It is assumed that both intensity and frequency still have diminishing, but positive, marginal returns, such that $\alpha_1, \beta_1 > 0$ and $\alpha_2, \beta_2 < 0$ for all q_x and f_x. Using this utility form and solving for the optimal choice of intensity and frequency of good *x* (Appendix B), the ratio of quantity and frequency is equal to a constant which does not depend on income or prices but only on the parameters in the utility function: Equation(6). These parameters may vary across individuals depending on an individual's 'taste' (i.e., how fast utility from an extra drink diminishes compared with how fast utility from an extra drinking occasion diminishes).

$$(5) U = (\alpha_1 q_y + \alpha_2 q_y{}^2)(\beta_1 f_y + \beta_2 f_y{}^2) + g(Q_y)$$

$$(6) \frac{q_x}{f_x} = \frac{\alpha_1 \beta_2}{\alpha_2 \beta_1}$$

Effect of Prices and Income

Because the income of the individual and price of good *x* does not affect the ratio of quantity to frequency, this implies that if the income increased or the price of good *x* decreased then both frequency and intensity would scale up by a constant, leaving the ratio unchanged. However, there may be an indirect effect of income on the ratio via the budget constraint, with higher incomes related to a lower ratio of intensity to frequency because individuals with higher incomes are likely to have a higher opportunity cost of the recovery time associated with an intense drinking session (Berggren and Sutton, 1999).

The fact that the ratio of intensity to frequency is constant in Equation(6) implies that the choice of the quantity of other goods *y* does not depend on the ratio or vice versa. However, the choice of other consumption goods such as good *y* may indicate an individual's preferential 'taste' for frequency versus intensity. For example, it is hypothesised that individuals who smoke (enjoy intoxication) are likely to have a higher ratio of intensity to frequency of drinking. Some individuals may also choose not to consume any of good *x* at certain prices (p_x and p_y) and income *M*, instead choosing to spend all their income on good *y*, resulting in their ratio of intensity and frequency being unobserved.

Explaining the patterns of alcohol use in rural Australia

In order to consider determinates of preferences for intensity versus frequency, the ratio of intensity versus frequency is analysed for self-reported alcohol consumption from individuals living in rural NSW.

Study Sample

This research was conducted in conjunction with a larger study, the Alcohol Action in Rural Communities (AARC) project. AARC is a randomised controlled trial of community based alcohol interventions being conducted in 20 rural communities in the Australian state of New South Wales. Baseline data involved a postal survey conducted in March 2005 for 7,895 individuals from the 20 communities to collect information on health status, patterns and frequency of alcohol consumption, demographics and other relevant variables. In order to measure frequency of consumption Individuals were asked "In the last 12 months, how often did you have an alcoholic drink of any kind?" Intensity was measured by asking "On a day that you have an alcoholic drink, how many standard drinks (10 grams of ethanol) do you usually have?"

The population was stratified by gender and age to reflect the specific characteristics of each community, as defined in the Australian Bureau of Statistics 2001 census reports (Australian Bureau of Statistics, 2001). For each of the 20 rural communities, approximately 400 people enrolled to vote with the Australian Electoral Commission were randomly selected to participate. Each participant was mailed a self addressed envelope which contained a cover letter explaining the study, along with the survey and a reply paid envelope. Two weeks after the initial survey was sent all participants were mailed a reminder letter asking them to complete the survey. Those participants who had not responded after 4 weeks were sent another survey.

Empirical Model

The theoretical result in Equation(6) implies that the ratio of intensity and frequency is determined by an individual's relative 'taste' for intensity versus frequency. The model is restated in natural log form in Equation(7) and transformed into an empirical model given in Equation(8).

$$(7)\ln\left(\frac{q_x}{f_x}\right) = \ln(\alpha_1) + \ln(\beta_2) - \ln(\alpha_2) - \ln(\beta_1)$$

$$(8)\ln\left(\frac{q_{xi}}{f_{xi}}\right) = h(Z_i) + \varepsilon_i$$

Where q_{xi} is the average quantity individual *(i)* consumes on each drinking occasion and f_{xi} is the frequency at which individual *(i)* drinks.

The parameters $\alpha_1, \alpha_2, \beta_1, \beta_2$ are considered a function $h(Z_i)$ of exogenous variables which affect individual *i*'s 'taste' for intensity and frequency. We also include a normally distributed random error term ε_i that allows for variation across individuals from any unobserved explanatory variables and other random errors.

The ratio of intensity to frequency is not always observed since some individuals choose not to consume any alcohol. Also, since some individuals may only rarely consume alcohol, e.g., when offered at a dinner party, this may distort the results because their high ratio of intensity to frequency may not indicate their true preferences for intensity versus frequency but rather, an opportunity for a free drink. For this reason in the current study, only 'regular' drinkers (those who state that they drink at least one day per month) are considered in the analysis.

Frequency is defined as the stated number of drinking sessions per month,[1] while intensity is the average number of standard drinks (10g ethanol per standard drink) consumed on each drinking occasion. The empirical model is separated into males and females because the biological impact, in terms of intoxication, of one standard drink is different for each sex.[2]

Explanatory Variables

A number of models with different sets of explanatory variables are estimated. Model 1 includes basic demographic variables as explanatory variables including: age, married (married or living with life partner=1), education (years of education); a dummy variable for those with other educational qualifications which could not be converted to years of education, five dummy variables for employment status (student, work casual or part-time, retired, home duties, unemployed) with the base case being those working full-time; household income in thousands of dollars per week (mid-point of selected household income band), including a dummy variable (over $1,500) for those individuals with a stated household income greater than $1,500 per week and two dummy variables for those that do not know or prefer not to state their income; a dummy variable non-Australian born (foreign=1); a dummy variable for Indigenous Australians (indig=1), and 19 dummy variables in order to control for the environmental factors of the 20 communities in the study.

Model 2 includes the same demographic variables along with the natural log of the total alcohol consumption (intensity multiplied by frequency). The theoretical model predicts that the ratio of intensity to frequency is a constant, which is simply determined by individuals'

[1] The stated frequency was answered from a pre-defined list of options; every day, 5-6 days per week, 4 days per week, 3 days per week, 2 days per week, 1 day per week, 2-3 days per month, about 1 day per month, less often, never. In the case of 5-6 days, a mid-point of 5.5 days was used. In the case of 2-3 days per month, a mid-point of 2.5 days per month was used. It was assumed that a month contained four weeks.

[2] The estimated equations for males and females were significantly different at the 1% level in the following analysis.

heterogeneous preferences for intensity versus frequency. Model 2, therefore, permits testing of whether the ratio of intensity to frequency changes with total alcohol consumption. It also allows the examination of the effect of the other demographic variables conditional on the total amount of alcohol consumed.

Model 3 includes the same explanatory variables for Model 2 along with two additional dummy variables, one for smoking status and one for private health insurance. This permits the investigation of the relationship between the ratio of intensity to frequency and these other consumption choices made by the individual.

Regression techniques

For each model, two different specifications are estimated, one using OLS on the truncated sample of regular drinkers and one using the Heckman sample selection maximum likelihood estimation to account for possible selection bias in the regular drinkers. The truncated OLS model is appropriate if being a regular drinker is determined randomly, such that unobserved factors do not affect the preference for intensity versus frequency and the probability of being a regular drinker (Verbeek, 2000).

The Heckman sample selection model is used to check the robustness of the estimated values to an alternate specification. With the Heckman model, it is assumed that the decision to abstain is separate from the choice of the ratio of intensity and frequency. However, in order for the equations to be identifiable, at least one additional explanatory variable needs to be included in the sample selection equation. In this case a dummy variable, which is equal to 1 if the individual has been to a licensed premises (e.g., pub or club) within the last year, is included in the selection equation. This variable attempts to measure an individual's attitude

towards the consumption of alcohol. It is assumed that individuals who are against the consumption of alcohol are less likely to go a licensed premises than an individual who prefers not to drink alcohol due to the taste or cost of alcohol. It is assumed that whether or not an individual has been to a licensed premises is unlikely to be related to his/her preference of intensity compared with frequency.

Results

Demographics

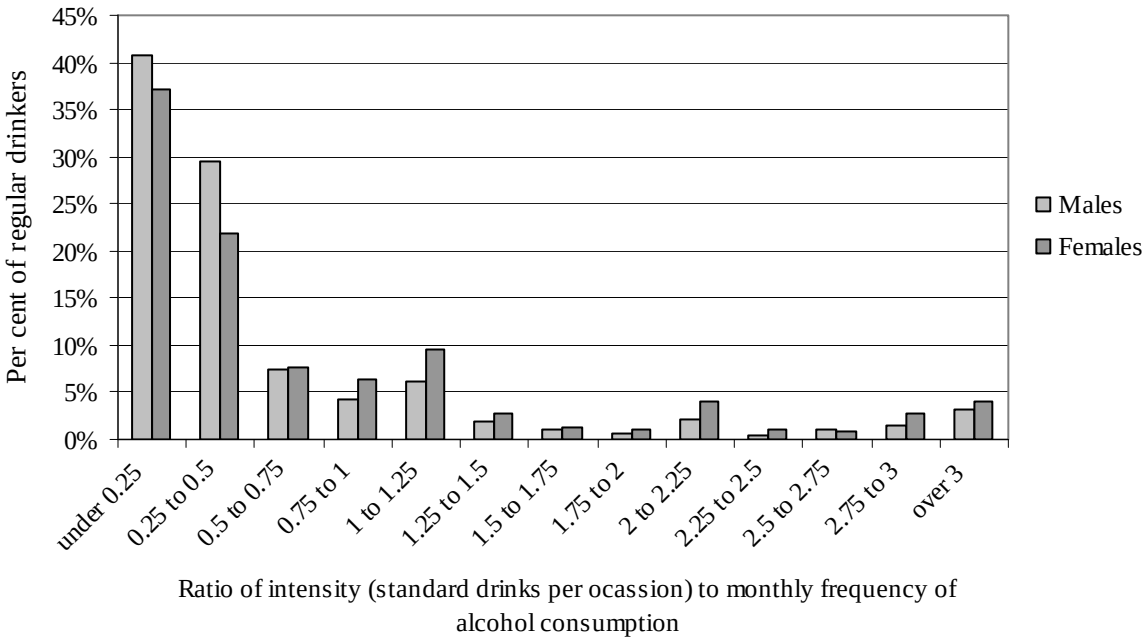
Of the 7,985 questionnaires sent out, 3,017 (38%) were returned with usable responses. The overall response rate is slightly lower than for the Australian NDSHS which used a combination of drop and collect (48% response rate) and telephone interview (38% response rate) techniques (Australian Institute of Health and Welfare, 2005). Females comprised 1,688 (56%) of the sample, and the mean age of respondents was 42 years (S.D.: 12; range 18-71 years). There were 560 (19%) smokers in the sample and 134 (4%) who did not indicate their smoking status. In the sample, 1395 (46.4%) individuals had completed post school education, while 23 individuals did not state their highest education level achieved. A weekly household income of less than $500 was reported by 507 (17%) individuals, and 573 (19%) had a weekly gross household income greater than $1500.

Alcohol use and ratio of intensity to frequency

Abstainers count for 10.5% of the sample while 75.5% are ‘regular’ drinkers (consume alcohol at least one day per month). For those ‘regular’ drinkers, the mean intensity is 4.3 and 2.9 standard drinks per drinking session for males and females respectively, with the average number of drinking sessions per month being 13.3 and 9.5 respectively. The distribution for the ratio of intensity to frequency for males and females can be seen in Figure 1. The distribution has a sharp spike at a low ratio which exponentially decreases as the ratio

increases. In general, of those regular drinkers, although females have both a lower intensity and frequency of consumption than males, they tend to have a higher ratio of intensity versus frequency than males because their frequency of consumption is lower by a greater proportion compared to intensity.

Figure 1. Percentage of male and female regular drinkers whose ratio of intensity versus monthly frequency of alcohol consumption falls into the following ranges



Truncated OLS versus Heckman specification

Tables 1, 2 and 3 display the male and female results respectively from Models 1, 2 and 3 for both the truncated OLS and Heckman selection models. With all Heckman models, there is a negative correlation between the error in the intensity/frequency ratio equation and that from the selection equation, though this is only significant at conventional levels for females. This suggests that for females there is some selection bias, with regular drinkers being more likely to prefer frequency over intensity than non-regular drinkers. However, it should be noted that the coefficients are relatively robust to the specification used with there being little difference in terms of direction and magnitude between the Heckman and OLS estimates. For

simplicity, the results and interpretation reported in the subsequent sections refer to the coefficients from the Heckman model.

Heckman Model Results

Model 1

Table 1 displays the male and female results for determinates of the natural log of the ratio of intensity versus frequency from Model 1. It is found that age significantly affects the ratio of intensity to frequency for both males and females ($p<0.001$ and $p<0.001$) with a 1% increase in age resulting in a 1.011% and 1.623% decrease in the ratio (at the mean), for males and females respectively. Education also plays a significant role for both males and females ($p=0.003$ and $p=0.001$) with a 1% increase in the years of education resulting in a 0.578% and 0.708% decrease in the ratio (at the mean).

For males, compared to those working full-time, those who are unemployed have a 52.5% higher ratio of intensity to frequency ($p=0.042$); those on home duties have a 68.4% higher ratio of intensity to frequency ($p=0.083$); those who are retired have a 29.5% higher ratio of intensity to frequency ($p=0.064$); while those working part-time or casually have a 29.9% higher ratio of intensity to frequency ($p=0.015$). Testing the overall significance of the community dummy variable on the preference of intensity versus frequency using an F-test, finds that for males the communities are significantly different from each other ($p=0.021$), while for females there does not appear to be any significant differences between the 20 communities ($p=0.581$).

Table 1. Model 1, OLS and Heckman results for the determinants of the preference for intensity versus monthly frequency of alcohol consumption

	MALES						FEMALES					
	Only regular drinkers			Heckman MLE			Only regular drinkers			Heckman MLE		
	Coeff.	SE	P-val.	Coeff.	SE	P-val.	Coeff.	SE	P-val.	Coeff.	SE	P-val.
Age (years)	-0.024*** (-1.013)	0.003	0.000	-0.024*** (-1.011)	0.003	0.000	-0.039*** (-1.599)	0.004	0.000	-0.039*** (-1.623)	0.004	0.000
Married	-0.275*** (-24.3)	0.086	0.001	-0.272*** (24.1)	0.084	0.001	-0.314*** (-27.3)	0.098	0.001	-0.267*** (-23.8)	0.096	0.005
Education (years)	-0.037** (-0.442)	0.014	0.010	-0.048*** (-0.578)	0.016	0.003	-0.050*** (-0.607)	0.017	0.004	-0.059*** (-0.708)	0.018	0.001
Education other	-0.629* (-50.3)	0.374	0.093	-0.800** (57.7)	0.365	0.029	-0.645* (-50.8)	0.356	0.070	-0.825* (-60.1)	0.443	0.062
Unemployed	0.406** (47.0)	0.205	0.048	0.432** (52.5)	0.212	0.042	0.450 (48.0)	0.340	0.186	0.492 (52.1)	0.392	0.210
Home duties	0.536 (62.1)	0.327	0.101	0.558* (68.4)	0.322	0.083	0.201* (21.5)	0.108	0.062	0.256** (28.6)	0.112	0.022
Retired	0.249** (27.3)	0.125	0.047	0.262* (29.5)	0.141	0.064	0.170 (16.8)	0.171	0.321	0.276 (31.1)	0.173	0.110
Student	0.250 (25.9)	0.201	0.213	0.355 (41.6)	0.222	0.110	0.190 (19.5)	0.153	0.215	0.179 (18.5)	0.182	0.326
Part-time/casual	0.243** (26.7)	0.114	0.033	0.267** (29.9)	0.110	0.015	0.058 (5.51)	0.089	0.518	0.037 (3.70)	0.089	0.673
Number in household (over 14 years)	0.037 (0.088)	0.040	0.350	0.040 (0.097)	0.035	0.254	-0.001 (-0.006)	0.035	0.982	-0.005 (-0.011)	0.035	0.898
Income ($'000)	0.026 (0.014)	0.135	0.847	0.011 (0.006)	0.135	0.935	-0.073 (-0.038)	0.128	0.569	-0.156 (-0.081)	0.134	0.244
Income >$1,500	-0.043 (-5.35)	0.154	0.779	-0.055 (-5.38)	0.153	0.720	-0.162 (-15.9)	0.150	0.280	-0.319** (-27.6)	0.160	0.047
Income DK	-0.474 (-40.4)	0.293	0.106	-0.486* (-40.3)	0.254	0.056	0.078 (5.35)	0.227	0.732	0.109 (10.6)	0.226	0.630
Income PNTS	-0.135 (-13.7)	0.159	0.397	-0.165 (-16.1)	0.159	0.301	0.117 (11.1)	0.159	0.460	0.059 (6.04)	0.159	0.710
Foreign	0.076 (6.96)	0.135	0.571	0.072 (7.41)	0.142	0.609	-0.090 (-9.39)	0.134	0.504	-0.157 (-15.3)	0.144	0.277
Indigenous	0.426* (49.2)	0.230	0.064	0.362 (39.6)	0.240	0.133	0.379 (39.8)	0.296	0.200	0.286 (31.7)	0.317	0.368
Constant	0.133	0.293	0.649	0.303	0.311	0.331	1.438	0.328	0.000	1.976	0.366	0.000
R-squared	0.145			-			0.22					
Sample size	1045			1183			1078			1478		

***, **, * significant at the 1%, 5% and 10% level respectively. For continuous explanatory variables, the parentheses contain elasticity evaluated at the mean, while, for dummy variables, the parentheses contain the estimated percentage change in the ratio for a unit change in the dummy variable. Income DK and Income PNTS refer to those who do not know or prefer not to say their income respectively. 19 community dummy variables are included in the regression though the results are not presented.

Model 2

Table 2 displays the male and female results from Model 2 where the natural log of total quantity is included in the regression. It is estimated that a 1% increase in the total quantity consumed results in a 0.246% and 0.461% decrease in the ratio of intensity versus frequency for males and females respectively, holding all else constant. Because of the mathematical relationship between total quantity and the ratio of intensity versus frequency in the model,[3] this infers that a 1% increase in total quantity consumed will result in a 0.38% rise in the intensity and a 0.62% rise in the frequency for males compared with a 0.27% rise in the intensity and a 0.73% rise in frequency for females, holding all other variables constant.

[3] $\Delta \ln(q/f) = \Delta \ln(q) - \Delta \ln(f)$ *and* $\Delta \ln(qf) = \Delta \ln(q) + \Delta \ln(f)$

Controlling for the total quantity consumed, similar significant effects are still observed for age, marital status and years of education for both males and females. Determinates that do change in terms of significance after controlling for total alcohol consumption include: home duties, which is no longer significantly different compared with those working full-time for males and females (p=0.140 and p=0.445); male students have a 52% higher ratio (p=0.044) than those working full-time; unemployed and retired females have a higher ratio than those females working full-time.

Table 2. Model 2, OLS and Heckman results for the determinants (including total alcohol consumed) of the preference for intensity versus frequency of alcohol consumption

	MALES						FEMALES					
	Only regular drinkers			Heckman MLE			Only regular drinkers			Heckman MLE		
	Coeff.	SE	P-val.	Coeff.	SE	P-val.	Coeff.	SE	P-val.	Coeff.	SE	P-val.
ln (total alcohol)	-0.246***	0.023	0.000	-0.248***	0.026	0.000	-0.467***	0.023	0.000	-0.461***	0.024	0.000
Age (years)	-0.025*** (-1.044)	0.003	0.000	-0.024*** (-1.035)	0.003	0.000	-0.038*** (-1.571)	0.003	0.000	-0.039*** (-1.612)	0.003	0.000
Married	-0.312*** (-27.0)	0.084	0.000	-0.311*** (-27.0)	0.080	0.000	-0.373*** (-31.3)	0.084	0.000	-0.333*** (-28.6)	0.083	0.000
Education (years)	-0.047*** (-0.565)	0.013	0.000	-0.061*** (-0.725)	0.016	0.000	-0.048*** (-0.586)	0.014	0.001	-0.055*** (-0.659)	0.015	0.000
Education other	-0.700* (-54.0)	0.390	0.073	-0.892** (-61.4)	0.351	0.011	-0.557* (-45.8)	0.336	0.098	-0.690* (-53.1)	0.381	0.070
Unemployed	0.362* (40.9)	0.198	0.068	0.403** (48.1)	0.204	0.048	0.672 (74.5)	0.480	0.162	0.718** (94.7)	0.338	0.034
Home duties	0.426 (45.4)	0.320	0.184	0.456 (52.9)	0.309	0.140	0.016 (1.22)	0.091	0.858	0.072 (7.37)	0.096	0.455
Retired	0.272** (30.3)	0.122	0.025	0.285** (32.4)	0.135	0.035	0.150 (15.2)	0.132	0.254	0.249* (27.8)	0.148	0.091
Student	0.303 (32.5)	0.206	0.142	0.428** (52.0)	0.213	0.044	0.121 (11.7)	0.142	0.394	0.107 (10.7)	0.157	0.496
Part-time/casual	0.248* (27.4)	0.110	0.024	0.268** (30.1)	0.106	0.011	-0.031 (-3.38)	0.076	0.679	-0.049 (-4.98)	0.077	0.524
Number in household (over 14 years)	0.016 (0.037)	0.038	0.679	0.022 (0.052)	0.034	0.527	0.037 (0.092)	0.030	0.215	0.027 (0.066)	0.031	0.377
Income ($'000)	0.092 (0.048)	0.129	0.474	0.071 (0.037)	0.130	0.582	-0.064 (-0.034)	0.109	0.558	-0.133 (-0.069)	0.115	0.251
Income >$1,500	0.041 (3.045)	0.148	0.782	0.014 (1.46)	0.147	0.922	-0.144 (-14.1)	0.127	0.254	-0.273** (-24.1)	0.138	0.047
Income DK	-0.511* (-42.8)	0.304	0.093	-0.520** (-42.1)	0.244	0.033	0.044 (1.94)	0.224	0.843	0.094 (9.11)	0.194	0.629
Income PNTS	-0.116 (-12.0)	0.153	0.446	-0.161 (-15.7)	0.153	0.295	0.009 (-0.037)	0.140	0.946	-0.022 (-2.22)	0.137	0.870
Foreign	-0.039 (-4.56)	0.125	0.756	-0.034 (-3.34)	0.136	0.804	-0.015 (-2.27)	0.124	0.901	-0.094 (-9.49)	0.124	0.447
Indigenous	0.349 (38.3)	0.221	0.114	0.291 (30.4)	0.231	0.208	0.369 (40.5)	0.242	0.127	0.282 (31.3)	0.272	0.300
Constant	1.131***	0.300	0.000	1.346***	0.318	0.000	2.531***	0.275	0.000	3.018***	0.316	0.000
R-squared	0.216						0.429					
Sample size	1045			1183			1078			1478		

***, **, * significant at the 1%, 5% and 10% level, respectively. For continuous explanatory variables, the parentheses contain elasticity evaluated at the mean, while, for dummy variables, the parentheses contain the estimated percentage change in the ratio for a unit change in the dummy variable. Income DK and Income PNTS refer to those who do not know or prefer not to say their income respectively.19 community dummy variables are included in the regression though the results are not presented.

Model 3

Table 3 displays the results from Model 3 for both the truncated OLS and Heckman sample selection models. The results indicate that smoking is positively correlated with the preference of intensity versus frequency, with smokers having a ratio 22% and 40% higher than non-smokers for males and females respectively after controlling for other factors. Private health insurance is negatively correlated with the preference for intensity versus frequency, though not significant for females at conventional levels of significance. Those with private health insurance have a ratio 19.0% and 9.1% smaller for males and females respectively than those without private health insurance, after controlling for other variables.

Table 3. Model 3, OLS and Heckman results for the determinants (including smoking and private health insurance) of the preferences for intensity versus frequency of alcohol consumption

	MALES						FEMALES					
	Only regular drinkers			Heckman MLE			Only regular drinkers			Heckman MLE		
	Coeff.	SE	P-val.	Coeff.	SE	P-val.	Coeff.	SE	P-val.	Coeff.	SE	P-val.
Smoker	0.211** (23.1)	0.083	0.011	0.201** (22.0)	0.078	0.010	0.362*** (43.1)	0.083	0.000	0.339*** (40.0)	0.083	0.000
Private health insurance	-0.217*** (-19.7)	0.069	0.002	-0.209*** (-19.0)	0.069	0.003	-0.048 (-4.93)	0.067	0.471	-0.094 (-9.08)	0.069	0.175
ln (total alcohol)	-0.264***	0.024	0.000	-0.264***	0.026	0.000	-0.481***	0.024	0.000	-0.478***	0.024	0.000
Age	-0.022*** (-0.950)	0.003	0.000	-0.022*** (-0.924)	0.003	0.000	-0.037*** (-1.535)	0.003	0.000	-0.037*** (-1.524)	0.003	0.000
Married	-0.307*** (-26.7)	0.086	0.000	-0.305*** (-26.5)	0.080	0.000	-0.323*** (-27.8)	0.087	0.000	-0.303*** (-26.4)	0.082	0.000
Education (years)	-0.043*** (-0.522)	0.014	0.003	-0.049*** (-0.589)	0.016	0.002	-0.047*** (-0.573)	0.015	0.001	-0.050*** (-0.599)	0.015	0.001
Education other	-0.697* (-54.0)	0.400	0.082	-0.768** (-56.3)	0.350	0.028	-0.541 (-45.4)	0.357	0.130	-0.622 (-50.2)	0.396	0.117
Unemployed	0.357* (40.4)	0.188	0.058	0.419** (50.5)	0.205	0.041	0.622 (65.4)	0.489	0.203	0.648* (81.7)	0.335	0.053
Home duties	0.357 (35.5)	0.327	0.276	0.395 (44.4)	0.307	0.198	0.001 (-0.331)	0.092	0.992	0.051 (5.20)	0.095	0.592
Retired	0.180 (18.8)	0.124	0.146	0.226* (25.0)	0.135	0.094	0.146 (14.8)	0.127	0.248	0.235 (26.1)	0.146	0.107
Student	0.391** (45.0)	0.198	0.049	0.456** (56.2)	0.211	0.031	0.182 (18.7)	0.145	0.209	0.140 (14.3)	0.156	0.369
Part-time/casual	0.234** (25.5)	0.111	0.036	0.245** (27.2)	0.106	0.020	-0.044 (-4.56)	0.077	0.572	-0.068 (-6.87)	0.076	0.368
Number in household (over 14 years)	0.012 (0.030)	0.038	0.745	0.021 (0.051)	0.034	0.532	0.036 (0.089)	0.030	0.234	0.030 (0.072)	0.030	0.329
Income ($'000)	0.142 (0.074)	0.129	0.270	0.115 (0.059)	0.131	0.376	0.007 (0.004)	0.113	0.952	-0.057 (-0.030)	0.117	0.625
Income >$1,500	0.153 (15.2)	0.150	0.307	0.107 (11.2)	0.150	0.479	-0.051 (-5.82)	0.135	0.706	-0.156 (-14.6)	0.140	0.265
Income DK	-0.447 (-38.9)	0.299	0.135	-0.435* (-37.1)	0.244	0.075	0.112 (9.15)	0.219	0.611	0.151 (14.9)	0.193	0.436
Income PNTS	-0.078 (-8.59)	0.151	0.603	-0.096 (-9.76)	0.154	0.533	0.112 (10.6)	0.146	0.446	0.060 (6.10)	0.137	0.664
Foreign	-0.080 (-8.41)	0.124	0.518	-0.056 (-5.47)	0.135	0.681	-0.128 (-12.7)	0.120	0.285	-0.144 (-14.0)	0.124	0.244
Indigenous	0.231 (22.6)	0.234	0.324	0.223 (22.1)	0.230	0.332	0.103 (9.47)	0.157	0.513	0.205 (22.0)	0.270	0.449
Constant	0.045***	0.316	0.001	0.154***	0.322	0.000	2.390***	0.292	0.000	2.784***	0.318	0.000
R-squared	0.240						0.445					
Sample size	1010			1177			1033			1474		

***, **, * significant at the 1%, 5% and 10% level respectively. For continuous explanatory variables, the parentheses contain elasticity evaluated at the mean, while, for dummy variables, the parentheses contain the estimated percentage change in the ratio for a unit change in the dummy variable. Income DK and Income PNTS refer to those who do not know or prefer not to say their household income.19 community dummy variables are included in the regression though the results are not presented.

Conclusion

While distinguishing between intensity and frequency may be unimportant for many goods, this is clearly not the case in terms of alcohol consumption where the likelihood of harm depends not only on the total amount of alcohol consumed, but also on the pattern of use (Babor et al., 2003; Rehm et al., 2003). This research has presented a theoretical model for the demand of alcohol where the intensity and frequency of alcohol consumption are separate choices made by individuals in order to maximise their utility. Data from rural Australia is then used in order to investigate the factors that affect patterns of alcohol use for this population group.

Before discussing the results, a number of important caveats should be mentioned. First, the functional form assumed for the utility function, while more flexible in terms of intensity and frequency of consumption than conventional demand models, is still a simplification. Secondly, the empirical analysis relies on self-reported alcohol use which is often, due to social desirability, an under representation of the true levels of alcohol consumed and little is known on whether individuals are more likely to underestimate intensity or frequency. Thirdly, the non-response rate which is typical of such a survey in Australia, is of some concern because it may create some selection bias.

In spite of these caveats, this paper provides insights into individuals' choices in regard to the pattern with which they consume alcohol. The theoretical model, given the assumption of a multiplicative quadratic model, found that individuals are not indifferent to intensity and frequency but choose a constant ratio of intensity versus frequency, regardless of price or income. The empirical results of this paper suggest that not only are preferences for intensity

versus frequency different for certain groups in society, but the ratio of intensity to frequency is also related to the total amount of alcohol consumed.

There are three possible reasons why the total amount of alcohol consumed may have a significant negative relationship with the preference of intensity versus frequency. First, there may be unobserved explanatory variables which affect both an individuals' preference for intensity versus frequency and the total amount of alcohol to be consumed. Secondly, the multiplicative quadratic functional form assumed for the utility function may be too simplistic in order to capture the sharp diminishing returns to intensity as heavy intoxication is reached. Therefore, in reality, as individuals increase their alcohol consumption, they are more likely to do so by increasing the frequency at which they drink rather than the average number of drinks consumed per occasion (decreasing the ratio of intensity versus frequency). Thirdly, individuals who consume large amounts of alcohol are more likely to under-report intensity rather than frequency.

After controlling for the total amount of alcohol consumed, those individuals (male or female) who are, older, more educated, working full-time or married, tend to drink in patterns that place them at low-risk of short-term alcohol-related harm (lower ratio of intensity to frequency) compared to their younger, less educated, unemployed and unmarried counterparts. Males who are retired, working part-time/casually, or students are more likely to drink in risky patterns than those working full-time. The significant differences in the preference for intensity and frequency between the 20 rural Australian communities for males, as opposed to females, suggest that community factors/cultures play an important role in determining patterns of alcohol use for males.

Those communities with higher proportions of individuals with low levels of education, who are younger and not in full-time work are likely to be experiencing greater amounts of acute alcohol-related harm due to risky patterns of use. Interventions aimed at improving patterns of use such as alcohol education and liquor licensing laws may be best targeted at these groups within communities.

The theoretical model proposed suggested that neither income nor price should affect the ratio of intensity to frequency. In the empirical model for communities in rural Australia, neither household income nor the number of individuals in the household over 14 years of age significantly affected either male or female preferences for intensity versus frequency, after controlling for the total amount of alcohol consumed. Unfortunately, data on alcohol prices were not available.

This paper has outlined the importance of distinguishing between the choice of intensity and frequency in terms of maximising utility with regard to alcohol consumption. While it has provided evidence to support that the intensity and frequency of consumption are distinct choices in terms of alcohol, it is only the beginning in this line of research. Further research is required in order to expand the current theoretical model to allow for greater flexibility in the way both intensity and frequency enters into the utility function. Also, empirical testing is needed to examine if changes in the price of alcohol affects the ratio of intensity to frequency at which it is consumed. This research can play an important role in informing policies which aim to minimising the harm associated with risky alcohol use by identifying those factors which influence preferences for risky alcohol use and those groups and communities who are most at risk.

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Appendix A

Solving the Lagrangian for the intensity (q_x), frequency (f_x) and total quantity of good y (Q_y), given the budget constraint.

$$L = U(q_x, f_x, Q_y) + \lambda(M - p_x q_x f_x - p_y Q_y)$$

$$\frac{\partial L}{\partial q_x} = \frac{\partial U}{\partial q_x} - \lambda p_x f_x = 0 \qquad \lambda = \frac{\partial U}{\partial q_x} \times \frac{1}{p_x f_x}$$

$$\frac{\partial L}{\partial f_x} = \frac{\partial U}{\partial f_x} - \lambda p_x q_x = 0 \qquad \lambda = \frac{\partial U}{\partial f_x} \times \frac{1}{p_x q_x}$$

$$\frac{\partial L}{\partial Q_y} = \frac{\partial U}{\partial Q_y} - \lambda p_y = 0 \qquad \lambda = \frac{\partial U}{\partial Q_y} \times \frac{1}{p_y}$$

$$\frac{\partial L}{\partial \lambda} = M - p_x q_x f_x - p_y Q_y = 0 \qquad M = p_x q_x f_x + p_y Q_y$$

$$\lambda = \frac{\partial U}{\partial q_x} \times \frac{1}{p_x f_x} = \frac{\partial U}{\partial f_x} \times \frac{1}{p_x q_x} \qquad (9) \frac{\partial U}{\partial q_x} \times q_x = \frac{\partial U}{\partial f_x} \times f_x$$

$$\lambda = \frac{\partial U}{\partial q_y} \times \frac{1}{p_1 f_y} = \frac{\partial U}{\partial x} \times \frac{1}{p_2}$$

Appendix B

Solving equation (9) using the following assumed utility function,

$$U = (\alpha_1 q_x + \alpha_2 {q_x}^2)(\beta_1 f_x + \beta_2 {f_x}^2) + g(Q_y)$$

$$\frac{\partial U}{\partial q_x} = (\alpha_1 + 2\alpha_2 q_x)(\beta_1 f_x + \beta_2 {f_x}^2)$$

$$\frac{\partial U}{\partial f_x} = (\alpha_1 q_x + \alpha_2 {q_x}^2)(\beta_1 + 2\beta_2 f_x)$$

$$\frac{\partial U}{\partial q_x} \times q_x = \frac{\partial U}{\partial f_x} \times f_x$$

$$(\alpha_1 + 2\alpha_2 q_x)(\beta_1 f_x + \beta_2 {f_x}^2) q_x = (\alpha_1 q_x + \alpha_2 {q_x}^2)(\beta_1 + 2\beta_2 f_x) f_x$$

$$(\alpha_1 q_x + 2\alpha_2 {q_x}^2)(\beta_1 f_x + \beta_2 {f_x}^2) = (\alpha_1 q_x + \alpha_2 {q_x}^2)(\beta_1 f_x + 2\beta_2 {f_x}^2)$$

$$\alpha_1\beta_1 q_x f_x + 2\alpha_2\beta_1 {q_x}^2 f_x + \alpha_1\beta_2 {f_x}^2 q_x + 2\alpha_2\beta_2 {f_x}^2 {q_x}^2 =$$
$$\alpha_1\beta_1 q_x f_x + \alpha_2\beta_1 {q_x}^2 f_x + 2\alpha_1\beta_2 {f_x}^2 q_x + 2\alpha_2\beta_2 {f_x}^2 {q_x}^2$$

$$\alpha_2\beta_1 {q_x}^2 f_x = \alpha_1\beta_2 {f_x}^2 q_x$$
$$\alpha_2\beta_1 q_x = \alpha_1\beta_2 f_x$$

$$\frac{q_x}{f_x} = \frac{\alpha_1\beta_2}{\alpha_2\beta_1}$$